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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
MAGEE, THOMAS J	
ART UNIT	**PAPER NUMBER**
2811	

DATE MAILED: 12/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/759,205	HOKAZONO ET AL.	
	Examiner	Art Unit	
	Thomas J. Magee	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-22 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-22 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 01202004.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections – 35 U.S.C. 103

1.The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1 – 4, 6 – 9, 11 – 13, and 15 – 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murthy et al. (US 6,235,568 B1).

3. Regarding Claim 1, Murthy et al. disclose a semiconductor device comprising:

a p-type silicon semiconductor region (202) (Figure 2f) (Col. 4, line 13 – 14),

an n-type diffusion region (224) formed in a surface region of the silicon semiconductor region, and

a Ni silicide film (240) (Figure 2k) formed in a surface region of the n-type diffusion region.

Murthy et al. <u>do</u> disclose that the silicide film is in-situ doped with boron (diborane gas source) (Col. 8, lines 60 – 63), thereby forming a p-type impurity diffusion layer extending from the surface of the film into the depth of the film. Murthy et al. do not disclose that the p-type diffusion layer has a peak concentration not lower than 1E20/cm3 at a preset depth and a concentration beyond an interface not higher than 5E19/cm3. However, the profile as shown, with the prescribed values, defines a Gaussian profile. It is routine in the art to conduct a series of tests to optimize doping profiles in in-situ doped layers and it would have been obvious to one

of ordinary skill in the art at the time of the invention to optimize parameters to attain the Gaussian doping profile as claimed in order to form an impurity doped contact region that would improve interface adhesion and grain growth for a device of improved reliability.

4. Regarding Claims 2 and 7, Murthy et al. disclose a semiconductor device, as discussed above, wherein the p-type impurity is B (Col. 8, lines 60 – 63).

5. Regarding Claims 3 and 8, Murthy et al. do not disclose, as discussed for Claim 1, that the peak concentration occurs at a depth of 30 nm from the surface of the film. However, it is routine in the art to conduct a series of tests to optimize doping/depth profiles in in-situ doped layers and it would have been obvious to one of ordinary skill in the art at the time of the invention to optimize parameters to attain the doping/ depth profile as claimed in order to form a doped contact region for a more efficient working device.

6. Regarding Claims 4 and 9, Murthy et al. disclose a semiconductor device wherein the n-type diffusion region is a source/drain region of the transistor (224) (Col. 6, lines 23 – 28).

7. Regarding Claim 6, Murthy et al. disclose a semiconductor device comprising:

a p-type silicon semiconductor region (202) (Figure 2f) (Col. 4, line 13 – 14),

a pair of n-type diffusion regions (224) separately formed in a surface region of the silicon semiconductor region,

a gate electrode (206) (Col. 4, lines 49 – 53) containing silicon and formed above part of the semiconductor region which lies between n-diffusion regions with a gate insulating film (203) (Col. 4, line 49) interposed therebetween,

a plurality of Ni silicide films (240) (Figure 2l) formed in surface regions of the pair of n-type diffusion regions (224) and in the upper surface region of the gate electrode.

Murthy et al. do disclose that the silicide film is in-situ doped with boron (diborane gas source) (Col. 8, lines 60 – 63), thereby forming a pair of p-type impurity diffusion layers extending from the surface of the film into the depth of the film. Murthy et al. do not disclose that the p-type diffusion layers have a peak concentration not lower than 1E20/cm3 at a preset depth and a concentration beyond an interface not higher than 5E19/cm3. However, it is routine in the art to conduct a series of tests to optimize doping profiles in in-situ doped layers and it would have been obvious to one of ordinary skill in the art at the time of the invention to optimize parameters to attain the doping profile as claimed in order to form doped contact regions for a more efficient working device.

8. Regarding Claims 11 and 15, Murthy et al. disclose a manufacturing method of a semiconductor device comprising:

doping n-type ions (224) (Col. 6, line 59) into a selected portion of a surface region of a p-type silicon semiconductor region (202) (Col. 4, line 13),

doping p-type impurity ions (234) (Figure 2h) into the entire surface region of the silicon semiconductor region (Col. 7, lines 5 –9),

activating n-type (source/drain) and p-type (tip implants) impurity ions to form an n-type diffusion region (224) in the surface region and a p-type impurity diffusion layer in a depth direction, and

performing a heat treatment to form a Ni silicide film in the surface region of the n-type diff-

usion region (Col. 9, lines 26 – 30) after depositing Ni (Col.9, lines 22 – 26) on the surface of the n-type diffusion region.

Murthy et al. <u>do</u> disclose that the silicide film is in-situ doped with boron (diborane gas source) (Col. 8, lines 60 – 63), thereby forming a p-type impurity diffusion layer after heating and formation of the Ni silicide film. Murthy et al. do not disclose that the p-type diffusion layer has a peak concentration not lower than 1E20/cm3 at a preset depth and a concentration beyond an interface not higher than 5E19/cm3. However, it is routine in the art to conduct a series of tests to optimize doping profiles in in-situ doped layers and it would have been obvious to one of ordinary skill in the art at the time of the invention to optimize parameters to attain the doping profile as claimed in order to form a doped contact region for a more efficient working device.

9. Regarding Claims 12 and 16, Murthy et al. disclose a manufacturing method of the semiconductor device, as discussed above, wherein the p-type impurity is B (Col. 8, lines 60 – 63).

10. Regarding Claims 13 and 17, Murthy et al. do not disclose, as discussed for Claim 1, that the peak concentration occurs at a depth of 30 nm from the surface of the film. However, it is routine in the art to conduct a series of tests to optimize doping/depth profiles in in-situ doped layers and it would have been obvious to one of ordinary skill in the art at the time of the invention to optimize parameters to attain the doping/ depth profile as claimed in order to form a doped contact region for a more efficient working device.

11. Claims 5, 10, 14, and 18, are rejected under 35 U.S.C. 103(a) as being unpatentable over

Murthy et al., as applied to Claims 1 – 4, 6 – 9, 11 – 13, and 15 – 17, and further in view of Tanaka et al. (US 6,790,723 B2).

12. Regarding Claim 5, Murthy et al. do not disclose a contact liner film formed on the n-type diffusion region with an opening portion to expose part of the surface of the n-type diffusion region and an electrode in contact with the surface of the region. Tanaka et al. disclose the presence of a contact liner film (415) (Figure 30A) formed on the n-type diffusion region (413) with an opening portion to expose the surface and an electrode (407) formed in contact with the surface. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Tanaka et al. with Murthy et al. to obtain contact structure for a more efficient working device.

13. Regarding Claim 10, as discussed above, Murthy et al. do not disclose the presence of liner films on n-type diffusion regions with openings over the regions and electrodes formed in contact with the surface. Tanaka et al. disclose a liner film (415) on at least a pair of n-diffusion regions (since the structure in Figure 30A is repetitive) with corresponding openings and electrodes (407) formed in the openings. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Tanaka et al. with Murthy et al. to obtain contact structure for a more efficient working device.

14. Regarding Claims 14 and 18, Murthy et al. do not disclose a contact liner film formed on the entire surface after formation of the Ni silicide and an inter-level insulating film on the entire surface with an opening portion to expose part of the surface of the n-type diffusion region through the insulating film and liner film, and an electrode in contact with the surface of the

region. Tanaka et al. disclose:

forming a contact liner film (415) (Figure 30A) on the entire surface of the device,

forming an inter-level insulating film (406) on the entire surface,

forming an opening portion which reaches the surface of the n-type diffusion region (413) in (through) the insulating film (406) and liner film (415), and

forming an electrode (407) in contact with the surface of the n-type diffusion region (413) in the opening portion.

It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Tanaka et al. with Murthy et al. to obtain contact structure for a more efficient working device.

15. Claims 19 – 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murthy et al. in view of Yu (US 6,372,585 B1).

16. Regarding Claim 19, Murthy et al. disclose a manufacturing method of a semiconductor device comprising:

doping n-type ions (224) (Col. 6, line 59) into a selected portion of a surface region of a p-type silicon semiconductor region (202) (Col. 4, line 13),

activating the n-type impurity ions to form an n-type diffusion region on the surface portion of the silicon semiconductor region (Col. 6, lines 47 – 53),

activating the p-type impurity ions (tip implants) to form p-type diffusion region (Col. 6, lines 47 – 53), in a depth direction of the semiconductor region, and

performing a heat treatment to form a Ni silicide film in the surface region of the n-type diffusion region (Col. 9, lines 26 – 30) after depositing Ni (Col.9, lines 22 – 26) on the surface of the n-type diffusion region.

Murthy et al. do disclose that the silicide film is in-situ doped with boron (diborane gas source) (Col. 8, lines 60 – 63), thereby forming a p-type impurity diffusion layer after heating and formation of the Ni silicide film. Murthy et al. do not disclose that the p-type diffusion layer has a peak concentration not lower than 1E20/cm3 at a preset depth and a concentration beyond an interface not higher than 5E19/cm3. However, it is routine in the art to conduct a series of tests to optimize doping profiles in in-situ doped layers and it would have been obvious to one of ordinary skill in the art at the time of the invention to optimize parameters to attain the doping profile as claimed in order to form a doped contact region for a more efficient working device.

Further, Murthy et al. disclose that p-type impurity (B) ions are doped into a surface (Col. 5, l ines 35 –37), but do not disclose that the ions form an amorphous surface portion. Yu discloses that (p-type) BF2 implants produce significant amorphization compared to B-implants (Col. 1, l ines 46 – 50). Hence, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the BF2 implant of Yu in Murthy et al. to suppress boron channeling and provide shallower junctions.

17. Regarding Claim 20, Murthy et al. disclose a manufacturing method, wherein the p-type impurity is B (Col. 8, lines 60 – 63).

18. Regarding Claim 21, Murthy et al. do not disclose, as discussed for Claim 19, that the

peak concentration occurs at a depth of 30 nm from the surface of the film. However, it is routine in the art to conduct a series of tests to optimize doping/depth profiles in in-situ doped layers and it would have been obvious to one of ordinary skill in the art at the time of the invention to optimize parameters to attain the doping/ depth profile as claimed in order to form a doped contact region for a more efficient working device.

19. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murthy et al. in view of Yu, as applied to Claims 19 – 21, and further in view of Tanaka et al.

20. Regarding Claim 22, Murthy et al. do not disclose a contact liner film formed on the entire surface after formation of the Ni silicide and an inter-level insulating film on the entire surface with an opening portion to expose part of the surface of the n-type diffusion region through the insulating film and liner film, and an electrode in contact with the surface of the region. Tanaka et al. disclose:

forming a contact liner film (415) (Figure 30A) on the entire surface of the device,

forming an inter-level insulating film (406) on the entire surface,

forming an opening portion which reaches the surface of the n-type diffusion region (413) in (through) the insulating film (406) and liner film (415), and

forming an electrode (407) in contact with the surface of the n-type diffusion region (413) in the opening portion.

It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Tanaka et al. with Murthy et al. to obtain contact structure for a more efficient working device.

Conclusions

21. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to **Thomas Magee**, whose telephone number is **(571) 272 1658.** The Examiner can normally be reached on Monday through Friday from 8:30AM to 5:00PM (EST). If attempts to reach the Examiner by telephone are unsuccessful, the nexaminer's supervisor, **Eddie Lee**, can be reached on **(571) 272-1732.** The fax number for the organization where this application or proceeding is assigned is **(703) 872-9306.**

Thomas Magee
November 28, 2004

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